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BOOK REVIEWS

These papers are contributions No. 26, 27 and 28, respectively, from the botany laboratories of Butler University. Address all communications regarding them to Butler University Botanical Studies, Butler University, Indianapolis, Indiana, U. S. A.

THE ACID RANGES OF SOME SPRING-FLOWERING HERBS WITH REFERENCE TO VARIATIONS IN FLORAL COLOR

By Rexford F. Daubenmire

It is of common knowledge, derived from even limited field observation, that color in the petals of many of our native flowers is quite variable. Where these variations seem constant, and are accompanied by other characters, taxonomists use color as one of the bases of species differentiation. On the other hand, some species, such as *Phlox divaricata,* treated in this paper, show gradations in floral color from pure white through blue and lavender to pink; these variations are evidently unaccompanied by other constant characters which might indicate racial differences.

While it is usual for flowers pigmented by anthocyans to vary in shades of color, it is seldom that yellow floral color is found varying. Bartlett (2) reports a variation in *Gratiola aurea,* and suggests that this variation is due to the genetic constitution of the plants. The species would illustrate an instance of duplicate genes having a cumulative effect. The bright yellow color denotes the presence of two color genes, only one of which is present in a more faded type of color, and none are present in the white forms. Cockerell's (4) account of a sunflower with rays prominently marked with red is another interesting variation from the customary constancy of yellow colors. The latter instance seems one of mutation, in the light of results obtained from the observation of the genetic behavior of the sport.

The remarkable tendency of some of these plants in retaining their particular color type favors a genetic explanation of such variations. The writer collected specimens of the tuberous roots of *Delphinium tricorne* during the normal flowering season and, keeping each color type separated from the others, planted the tubers in beds. The following spring each group of plants displayed colors which were evidently identical to what they were before being transplanted into a very different type of soil.

A similar instance of such constancy was related to the writer by Mr. Charles C. Deam, of Bluffton, Indiana, who has a specimen of the white type of *Phlox divaricata* in his botanical gardens which has retained its

original color each of the six or seven years since it was transplanted into the garden.

It is questionable as to whether such albino form should be merely mentioned in species descriptions, or whether they should be given the rank of form, variety, or even species. Plants such as *Campanula americana, Scutellaria canescens, Impatiens pallida, Prunella vulgaris* and *Vernonia altissima,* have, in the writer's observation, albino forms. That *Vernonia* may show an intermediate stage between the purple and white forms (3) is further evidence to support the theory of color being due in some species to duplicate genes having cumulative effect.

Quite a contrast to the previously named instances of color constancy is the note of Fernald (6), who observed an irregular annual change in the color of the petals of Hepatica plants which he had transplanted into his garden. This writer expressed a belief that the varying amounts of leaf mulch with which he treated the plants each year might have caused such changes.

The matter of a chemical difference in substratum being responsible for different floral colors has been repeatedly demonstrated by several workers, notably, Molisch, 1897 (7), Atkins, 1923 (1), and Coville, 1924 (5), all of whom found that the addition of aluminum sulphate to soil produced acid conditions which resulted in pink floral color in Hydrangea in contrast to the blue color of such plants on neutral or alkaline soils.

It was thought that, in a study of several native flowers, a parallel instance to the foregoing works might be found, namely, one in which the soil reaction would influence floral color indirectly by its affect on the solubility of certain chemicals in the soil, as was especially noted in Atkins' paper. Since it has been found that the acidity of the cell sap within the petals also may control the litmus-like reaction of the anthocyans, it was suspected that an instance might be found wherein soil reaction may have a bearing upon the sap acidity and hence affect color differences.

The present paper contains the results of an attempt to demonstrate a possible correlation between the acid ranges of the soils of some spring-blooming herbs found in Indiana, whose floral variations were striking, with the extreme color types. Only the soil actually clinging to the roots of the plant when dug was used, and only those specimens of each species were selected for study which demonstrated extremes of the particular type. It was intended in collecting to obtain several

specimens from widely separated parts of the state and from different habitats in each locality. The pH ranges of each color type for each species is presented with other summarized data in the following table. The reaction values were determined by the quinhydrone method:

SUMMARY OF DATA DERIVED FROM 249 SOIL SAMPLES

SPECIES	No. of Counties	Color Forms	No. of Samples	Acid Range	pH Scale 5.0 6.0 7.0 8.0
Phlox		Pink	31	6.1-7.9	
divaricata	8	Blue	31	5.3-8.0	
		White	19	5.7-7.8	
Phlox		Pink	12	6.1-7.1	
bifida	1	Lavender	8	6.1-8.1	
		Blue	4	6.3-6.5	
		White	3	6.7-7.5	
Tradescantia		Pink	11	5.1-6.1	
brevicaulis	4	Purple	10	5.0-6.4	
		Blue	18	4.9-7.4	
Dodocatheon		Pink	10	5.0-6.4	
meadia	1	White	10	5.0-5.9	
Delphinium		Blue	18	6.4-6.9	
tricorne	3	Blue and White	17	6.0-7.3	
		White	18	6.3-6.9	
Hepatica		Blue	7	5.5-7.5	
acutiloba	3	White	11	5.4-7.7	
Lupinus		Blue	5	6.4-7.0	
perennis	1	White	6	6.0-6.9	

A glance at the plotted acid ranges is sufficient to demonstrate that the results of this work are negative. There is no evident correlation between the color types and any particular part of the pH range of the species. That negative results would be found, at least for some species, was quite evident when, during the collecting of the soil samples, the writer found the roots of two specimens of Delphinium very intimately interwoven, one of which bore normal dark-blue flowers and the other the unusual white flowers.

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FACTORS FAVORING THE PERSISTENCE OF A RELIC ASSOCIATION OF EASTERN HEMLOCK IN INDIANA[1]

By Rexford F. Daubenmire

Scattered through the deciduous forests of Indiana there are relic colonies of eastern hemlock, *Tsuga canadensis*. These colonies, with quite an appreciable group of other species, including herbs and shrubs (1), are generally considered as remnants of a previous southern extension of their natural species ranges. After these species had been forced southward by the conditions accompanying the advancing ice caps, their postglacial movements, in keeping pace with the retreating ice masses back to their original climax ranges, were very irregular. Thus, in the course of postglacial reorganization of the vegetation, hemlock as a species resumed its more northerly range found in the Lake Forest which covers the area immediately north of the Great Lakes. However, the irregularity of the northward migration resulted in the isolation of numerous colonies in territory which ecologically belonged to another type of association, and which territory eventually would be claimed by the latter species as they too resumed their more northerly range in the postglacial period. When such relic communities become surrounded by the natural climatic climax of the region, there is the inevitable struggle for the possession of the land surface. During the shifting of the associations through such a period of intense competition for space, the relic species usually come to occupy that part of the topography which is less favorable to the natural climatic species, *i. e.*, where competition is less keen. And so it is that relic colonies or associations are usually to be found where the adverseness of ecological factors allow the relic to compete successfully with the more indigenous species, whether they eventually dwindle to the extinction of the outposts, or whether they become established as minor edaphic climaxes.

A series of ecological investigations was made by the writer in order to get a comparative measurement of the factors as they exist in the typical broadleaf Beech-Maple forest and in a relic coniferous association of hemlock. The following accounts of soil moisture, soil acidity and evaporation studies will be found in more detailed form in another

[1]This paper was delivered in part before the Colorado-Wyoming Academy of Science at Boulder, Colorado, November, 1930.

paper by the writer (3). All these investigations were carried out in the northern part of Parke county, Indiana, where one of the most extensive and most successfully competing areas of such relic hemlock colonies is found.

The soil of this region is underlain immediately by a soft sandstone which has been eroded down into a dendritic pattern of sandstone canyons or steep bluffs which may be composed of soft shale. In this area hemlock forms dense and almost pure stands along the upper limits of the bluffs and canyons and a narrow strip of gradually sloping land immediately next to the precipice rim. The Beech-Maple climax of the region is an upland forest climax which usually comes down to the immediate edge of the hemlock association. Since bluffs which are not inhabited by hemlock do not develop into the Beech-Maple climax, it was concluded that some set of conditions peculiar to the precipice areas were so unfavorable to Beech-Maple development that here the hemlock could successfully compete. The study includes investigations into air and soil temperatures, evaporation, soil moisture and soil acidity, in both hemlock and Beech-Maple associations, during the part of the growing season from the middle of June to the first of September of 1929 and 1930.

A duplicate series of soil samples from the 1, 3, 6, 12 and 18-inch layers of soil was taken in both associations each week for soil-moisture studies. When the moisture contents of the two soils were compared with their respective wilting coefficients, derived arithmetically from the moisture equivalents (2), some very significant facts were brought to light. In the upper layers of hemlock soil, the moisture content went below the wilting coefficient, *i. e.,* no growth water was available, from the middle of July throughout the summer, except for a period immediately following a rain. The lower layers of soil under hemlock are almost constantly lacking in growth water during this period, due to a small percentage of penetration. This latter condition is undoubtedly the result of the root habit of hemlock, which has a most intricate and matlike formation of rootlets about one inch thick just beneath the duff and completely covering the soil in the denser stands. This system of rootlets increases the absorptive surface and presents it in a manner which is conducive to nearly complete absorption of the precipitation before any water can percolate below the root layer. Beech-Maple soils were found to contain growth water at all depths throughout the summer. A constant supply of growth water is of great importance to mesic plants, and its lack under the hemlock may alone be responsible for the

inhibition of beech and maple seedlings from such places as the hemlock occupies. This deficiency in soil moisture under hemlock may be attributed largely to the tree itself; however, in view of the fact that Beech-Maple trees do not get established on such ridges which are unoccupied by the hemlock, it would seem to indicate that the location alone is an initial factor in drought because of the perfect drainage incurred by the proximity to a steep incline.

The acid ranges of both surface and subsoils (6-inch depth) in both associations were determined by twenty sets of soil samples (one surface and one subsoil sample) taken under five different stands of the hemlock, and fifteen sets from four different localities in the Beech-Maple. When compared, the acid ranges of the surface soils varied widely between the two forest types and there was an appreciable gap of six-tenths of a pH between the two ranges when plotted on the same scale (3). Hemlock surface soil had an acidity of pH 3.6 to 4.7, and the Beech-Maple ranged from pH 5.3 to 7.0. The subsoils occupied an intermediate portion of this part of the scale and their ranges overlapped so much as to indicate no great difference in acidity between the relic and broadleaf soils at this layer. Such a marked acidity of the hemlock surface soils is probably a cause for the exclusion of other species once the association is started, rather than an edaphic condition which is originally conducive to the establishment of the community. In fact, the hemlock seems to inhibit other species so completely as to keep out practically all of the numerous herbs which grow typically under Beech-Maple.

The temperatures of the soils were taken with glass-rod chemical thermometers thrust horizontally out into the soil at 1, 3 and 6-inch levels below the surface, from a wood-lined trench. Surface soil temperatures were found to be essentially alike in both associations, which was to be expected, since evaporation (3) and air temperature at 6 inches above the forest floors, vital factors in the control of soil temperature, were found to be equal also in the two forests. The average temperatures of the 3 and 6-inch layers under hemlock were 1 and .5 degrees C. lower, respectively, than these layers under the Beech-Maple (3). While this difference is slight, it gives the physiological advantage again to the Beech-Maple association.

Average daily fluctuation ranges are negligible in both the air temperature studies, being only .7°C greater in the hemlock, and in the soil temperature study, where they are almost identical.

The following table shows a summary of data derived from temper-

ature readings (Centigrade) taken at 6:00 a. m., 12:00 m. and 6:00 p. m., on one day of each week:

TEMPERATURE READINGS

			Average Daily Fluctuation	Average Temperature
AIR	Hemlock		8.6	22.9
	Beech-Maple		7.9	23.1
SOIL	Hemlock	1″	2.3	19.9
		3″	1.5	18.1
		6″	0.8	17.9
	Beech-Maple	1″	2.2	19.8
		3″	1.4	19.1
		6″	0.8	18.4

SUMMARY

A comparison of several vital ecological factors in a relic colony of hemlock and in its surrounding and more indigenous climax of Beech-Maple, indicate that whenever these factors differ (in soil moisture, soil temperature and soil acidity), the most favorable extreme is found in the hemlock environment. Air temperature and evaporation studies indicate no appreciable difference between the environments of the wide-spread climax and the relic edaphic climax.

In view of the factors considered, a particular site, which by means of its topography is conducive to extreme drainage and consequently presents a dry soil for plant occupation, is the only adverse condition which the hemlock may make use of in getting established. Once established, a secondary group of conditions arises, through the presence of the hemlock itself, which tend to inhibit the seedlings of competing plants and thus secure the permanency of this relic association.

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FAT DEPOSITS IN CERTAIN ERICACEÆ[1]

By ORAN B. STANLEY

The purpose of this work was to investigate the structures of certain available plants of the family Ericaceæ with special interest in fat deposits in the tissues.

HISTORICAL. Priestly and Hinchliffe (8) have called attention to the characteristic appearance of plants growing in peat moors of England. These plants are of a stunted nature, dark green in color, leathery in texture, and with very little leaf surface. These characteristics, along with certain others, have led to these plants being grouped with xerophytes. This seems strange, as xerophytism is associated, normally, with scarcity of water.

The cuticle of a plant consists largely of cutin, a substance derived from various organic acids, mainly oxyfatty acids. The rapid deposit of cutin on a young vascular plant would therefore suggest the presence of a large amount of fatty acid. Priestly has confirmed this assumption by anatomical investigation of several of the peat plants from the Yorkshire moors.

An explanation is made on the basis that peat plants are growing in a soil that is deficient in oxygen. If a root grows under conditions of deficient oxygen, one of the best sources of energy for its constructive metabolism would be found in the converting of carbohydrates into fatty acids, with the elimination of CO_2. Such changes as these have been shown to exist in the living plant. Behind the growing region, these fatty acids seem either to be deposited on the walls as insoluble calcium soaps, or to be carried with the sap up in the vascular cylinder as soluble potassium or sodium soaps, or as free fatty acids. Peat soils are deficient in calcium, so it may be expected that the fatty acids would be carried away from the roots, up into leaf and stem.

Pearsall (7) states also that sour soils are notoriously deficient in calcium, and comparatively rich in sodium and potassium. If Ca is scarce, the fatty acids will be carried upward in the plant as soluble soaps of Na and K. If Ca is abundant, the fatty acids will be deposited in roots as insoluble calcium soaps

[1]A thesis submitted as partial fulfillment for the distinction *Magna Cum Laude*, Department of Botany, Butler University, June, 1931.

METHODS. Collection of the following material was done by Dr. Stanley A. Cain, of the Department of Botany at Butler University in Indianapolis. Leaf and stem material of *Cassandra calyculata* D. Don, was collected from a peat substratum in Mineral Springs bog, in Northern Indiana. Leaf and stem material of *Arctostaphylos uva-ursi* (L.) Spreng. was collected from sand habitat of Wilson dunes, Northern Indiana.

Roots of *Kalmia latifolia* L., *Dendrium prostratum* (Loud.) Small and *Rhododendron catawbiense* Michx., from both upland peat, Cain (1), and sand-clay habitats, were collected from the Great Smoky mountains in Eastern Tennessee.

The following were collected by the writer: *Vaccinium macrocarpon* Ait., roots, stems and leaves, from the Gaston peat bog north of Muncie, Indiana, and *Gaylussacia baccata* K. Koch, *Vaccinium stamineum* L., and *Vaccinium vacillans* Kalm. from sand-clay habitats in the Sycamore Creek region of Morgan county, Indiana. Part of this material was preserved in 4-60 formalin alcohol, part in a weak formalin solution, and some was dried or sectioned fresh.

Comparisons of the same material treated in different ways showed that the treatment did not alter the amount of fat in the tissue, as determined by the staining method described below.

Some difficulty was experienced in sectioning the smaller roots and stems, as well as leaves, because of the necessity of avoiding imbedding methods. The fats, had the material been cut in paraffin, would have been removed by the action of the higher grades of alcohol and chloroform, as Gatenby (4) and McClung (6) point out in their texts on microscopical technique

Freehand sectioning was employed with a fair degree of success, but a method of cutting the sections on a sliding microtome (the material being held between pith), proved most satisfactory. Even then, some of the more delicate tissues were sometimes torn and rendered useless.

As a stain, Oil Red O proved to be the most desirable of several fat stains tried. Sudan III and Sudan IV were both tried in solutions of 70 per cent. alcohol and in acetone alcohol solutions like that used by Miss Haynes (5). Oil Red O gives a much brighter stain than either of the two Sudans. It was first used in a 70 per cent. watery solution of pyridine, as employed by Proescher (9). The one objection to pyridine is its extreme volatility and stifling odor. The Oil Red O was then tried in a solution of one part acetone to one part of 50 per cent. ethyl

alcohol, and this stain was used throughout the work. A saturated solution of the stain was prepared, allowed to stand over night, with occasional shaking, and then filtered before using. The sections were cut in water, transferred to 70 per cent. alcohol for five minutes, then to the stain for about one minute, then washed in 70 per cent. alcohol and mounted in the glycerine jelly suggested by Chamberlin (2). The mount was then sealed with balsam.

A counterstain of Delafield's hæmatoxylin or Unna's polychrome methylene blue, as described by Conn (3), may be used with this stain, but it seemed more advisable to omit this counterstain, since microphotographs of the tissue were to be made and they would not differentiate between a red and a blue staining tissue.

RESULTS AND DISCUSSION

I. Plants Grown in Sand-Clay Substrata. In *Gaylussacia baccata* K. Koch., the old root had a thin cuticle, a fatty periderm internal to the pericyclic fibers, and a few fat globules scattered through the phloëm (Figure 1). The young stem had a cuticle, fatty deposits in the epidermis, and epidermal hairs taking a fat stain. Scattered fat globules were present in the cortex and pith (Figures 2, 3). The old stem had a cuticle partly surrounding the section, and fat deposits as globules and as linings of the cell walls in the epidermal cells. A fatty periderm was present, internal to the pericycle. Fat globules were present in the cortex, phloëm, phloëm rays, xylem rays and pith (Figures 4, 5).

In *Vaccinium vacillans* Kalm. the young stem was covered with a heavy cuticle, and fairly large numbers of fat globules were deposited in the epidermis, especially in the guard cells of the stomata (Figure 6). The old root had a rather thin cuticle. Fat was present in the epidermis as deposits on the walls of the cells and as globules in the cells. A fatty periderm was present internal to the pericycle (Figure 7).

In *Vaccinium stamineum* L. only the young stem was available for examination. Fat globules were found in the epidermal cells, and a cuticle was present.

The young leaf of *Arctostaphylos uva-ursi* (L.) Spreng. had a cuticle, epidermal hairs and some fatty deposits in the walls of the epidermal cells. The mesophyll had practically no fat globules. The old leaf had a heavy cuticle, also fat deposited as globules in the epidermis. The

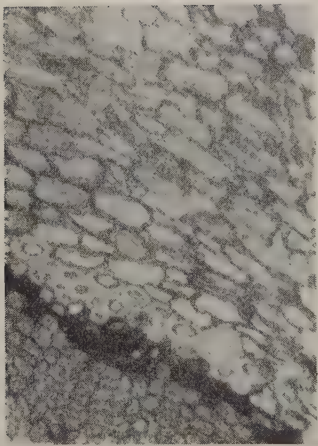

FIGURE 1

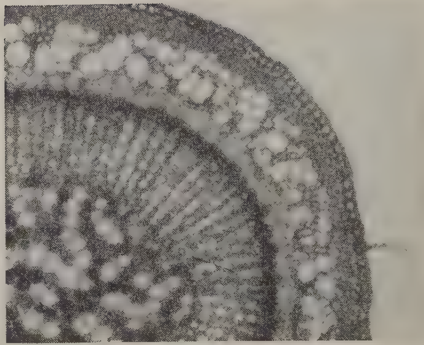

FIGURE 2

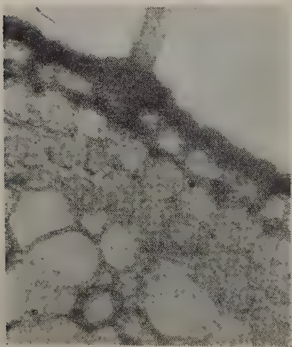

FIGURE 3

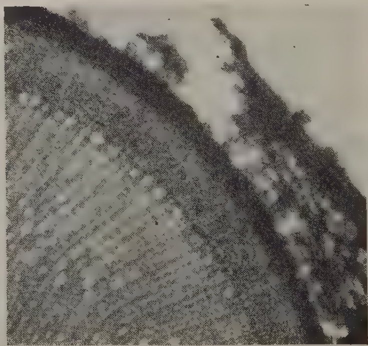

FIGURE 4

FIGURE 5

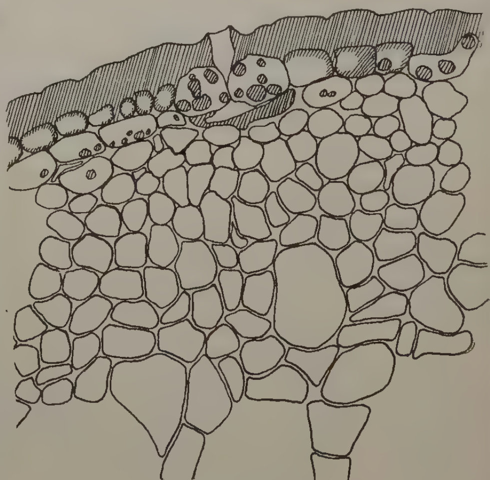

FIGURE 6

FIGURE 1. Section of old root of *Gaylussacia baccata*. Note fatty periderm just beneath the pericyclic fibers.

FIGURE 2. Section of young stem of *Gaylussacia baccata*, showing cuticle, epidermal hairs and fatty deposits in epidermal region.

FIGURE 3. Portion of young stem in Figure 2 in detail, showing heavy cuticle and fat deposits in epidermal cells.

FIGURE 4. Section of old stem of *Gaylussacia baccata*. Note heavy periderm which is replacing the outer tissue, this outer tissue being lost.

FIGURE 5. Portion of periderm from Figure 4, showing details.

FIGURE 6. Camera lucida drawing of a portion of the stem of *Vaccinium vacillans*, showing heavy cuticle and fat deposits in guard cells of stoma. Shaded portions represent deposits taking a fat stain.

FIGURE 7. Section of old root of *Vaccinium vacillans*. Note heavy periderm internal to pericyclic fibers.

FIGURE 8. Camera lucida drawing of a portion of a cross section of the leaf of *Arctostaphylos uva-ursi*, showing upper and lower cuticles and fat globules deposited in the palisade and mesophyll regions of the leaf. Shaded portions represent deposits taking a fat stain.

FIGURE 9. Section of old stem of *Cassandra calyculata*, showing disintegration of tissue from periderm outward.

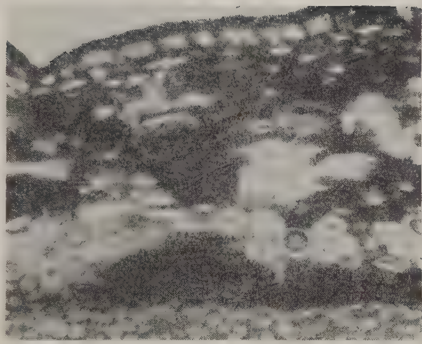

FIGURE 7

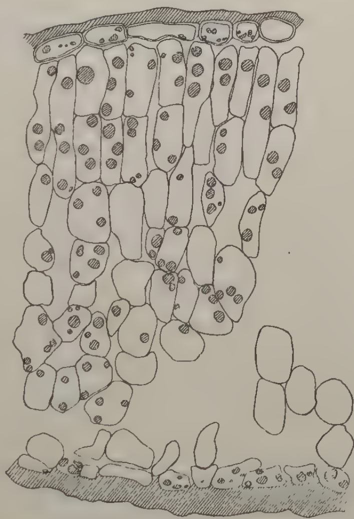

FIGURE 8

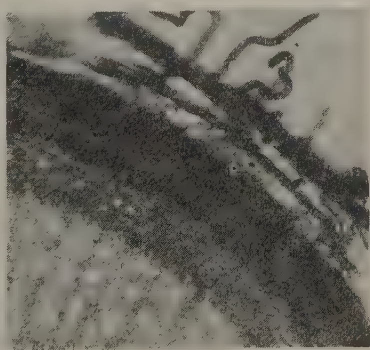

FIGURE 9

mesophyll was densely filled with fat globules (Figure 8). A cuticle and the presence of fat globules in the epidermis marked the young stem. The old stem also had a cuticle present. Fat was found in the epidermis both as globules and as deposits on walls of the cells. Fat globules were also sparsely scattered through parts of the cortex and xylem rays.

The young root of *Dendrium prostratum* (Loud.) Small was lacking cuticle and epidermis. Fat deposits were found in the walls of the cortex. Fatty deposits were also noted in the periderm, which was internal to the pericyclic fibers. Fat globules were noticeable in phloëm, phloëm rays and xylem rays.

Kalmia latifolia L. had the young root lacking cuticle and epidermis. Fat deposits were abundant in the walls of the cortex and periderm.

In *Rhododendron catawbiense* Michx. the young root likewise was lacking cuticle and epidermis. The cortex, too, was mostly gone. Fat deposits were noted in the walls of the periderm and as globules in the heart of the xylem.

II. Plants Grown in Peat Substrata. The studies of *Vaccinium macrocarpon* Ait. showed the old root to be lacking cuticle and epidermis. Fat deposits (not very heavy) were found in the walls of the periderm. The young stem had a cuticle present, and fat deposits as globules in the epidermal cells were common. A fatty periderm was present, internal to the pericycle, and fat globules in the xylem rays and pith were also noted. The old stem was lacking cuticle, epidermis and cortex. This tissue was lost, as the fatty periderm formed internal to the pericycle. The leaf was surrounded by a cuticle and the mesophyll contained numerous fat globules.

The old stem of *Cassandra calyculata* D. Don. had a cuticle and numerous epidermal hairs taking the fat stain. A fatty periderm was present internal to the pericycle. Fat globules in the xylem rays and pith were also noted. The tissue from the periderm outward was disintegrated and rapidly falling off (Figure 9). A cuticle and epidermal hairs were present in the young stem. There was, however, no trace of a periderm.

The young root of *Dendrium prostratum* (Loud.) Small was lacking cuticle and epidermis. The cortex was seen to have fatty deposits on the walls, and a periderm containing fat globules and fat deposits on the walls was very evident. Some fat globules in the xylem rays were also noted.

Rhododendron catawbiense Michx. had the young root lacking

TABLE I. PLANTS GROWN IN SAND-CLAY SUBSTRATA

Species	Organ	Cuticle	Epi-dermis	Peri-derm	Cortex	Phloëm	Phloëm Rays	Xylem Heart	Xylem Rays	Pith
Gaylussacia baccata K. Koch	Old root	w		W		G				
	Young stem	W	g-hairs		g					g
	Old stem	W	g-w	W	g	g	g		g	g
Vaccinium stamineum L.	Young stem	W	g							
Vaccinium vacillans Kalm	Young stem	W	G		g					
	Old root	w	w-g	W						
Arctostaphylos uva-ursi (L.) Spreng.	Young leaf	W	w-hairs		Mesophyll with practically no fat globules					
	Young stem	w	w-hairs							
	Old leaf	W	g		Mesophyll densely filled with fat globules					
	Old stem	W	w-g		g				g	
Dendrium prostratum (Loud.) Small	Young root			W	w	g	g		g	
Rhododendron catawbiense Michx.	Young root			W				g		
Kalmia latifolia L.	Young root			W	w					

Explanation: **W**, large deposit of fat in cell walls; w, small deposit of fat in cell walls; **G**, large deposit of fat as globules in cells; g, small deposit of fat as globules in cells.

TABLE II. PLANTS GROWN IN PEAT SUBSTRATA

Species	Organ	Cuticle	Epi-dermis	Peri-derm	Cortex	Phloëm	Phloëm Rays	Xylem Heart	Xylem Rays	Pith
Vaccinium macrocarpon Ait.	Old root			W						
	Stem	W		W					g	g
	Leaf	W			Mesophyll with fat globules					
Cassandra calyculata D. Don	Old stem	W	w-hairs	W					g	g
	Young stem	W	w-hairs							
Dendrium prostratum	Young root			wg	w				g	
Rhododendron catawbiense	Young root			w				g		
	Old root			w				g	g	
Kalmia latifolia	Young root			w						

Explanation: **W**, large deposit of fat in cell walls; w, small deposit of fat in cell walls; **G**, large deposit of fat as globules in cells; g, small deposit of fat as globules in cells.

cuticle, epidermis and cortex. A periderm with fat deposits in the walls of the cells and some globules in the heart region of the xylem constituted the fat deposits in this specimen. The old root was like the young root above, but with some fat globules in the xylem rays, as well as in the heart region of the xylem.

The young root of *Kalmia latifolia* L. was lacking cuticle, epidermis and practically all of the cortex. A heavy periderm with fat in the walls of the cells was the extent of fat deposits in this species.

Relation of Fat Deposits in Root and Stem. Table I furnishes the following calculations: (1) Fat occurred in fifteen places out of a possible forty in the roots studied. (2) There were twenty-three deposits out of a total of forty-eight possibilities in the stem. Reducing these fractions to a common denominator, a total of forty-one fat deposits are found for root and stem. Taking this total number of deposits as 100 per cent., it is found that 43.9 per cent. of the total number of deposits occurs in the root, while 56.1 per cent. occurs in the stem.

Table II, similarly, will show that fat occurs in roots to the extent of 35.3 per cent. of the total occurrence, while 64.7 per cent. of the fat deposited occurs in the stem.

This seems to bear out some of the theory of work previously mentioned. The deposits in plants from the peat substrata would be found to a greater extent in the stem on account of the lack of calcium and the comparative abundance of sodium and potassium in the peat substrata.

Occurrence of Fatty Periderm. Following the same procedure as above, it is found that the periderm occurs as follows:

Sand-Clay Substrata—Roots, 85.7 per cent.; stems, 14.3 per cent.
Peat Substrata—Roots, 60 per cent.; stems, 40 per cent.

Again a decrease in the occurrence of periderm in the roots of plants from peat substrata is shown, and there is a corresponding increase in occurrence of periderm in the stems of those plants.

This problem was suggested and directed by Dr. Stanley A. Cain.

SUMMARY

1. Nine species of Ericaceæ, representing seven genera, were studied with the purpose of investigating the extent and localization of fat deposits.

2. Cuticle, taking a fat stain, was present in all species where the outer tissues had not been lost.

3. Epidermal hairs, taking a fat stain, were present in three species, *Gaylussacia baccata, Arctostaphylos uva-ursi* and *Cassandra calyculata.*

4. A periderm was present in 85.7 per cent. of the roots and 14.3 per cent. of the stems of plants grown in sand-clay substrata, and in 60 per cent. of the roots and 40 per cent. of the stems of the plants grown in peat substrata. Periderm was always formed internal to pericyclic fibers

5. Fat globules were present in the pith of three species.

6. Fat globules were present in the heart or rays of the xylem in five species.

7. In *Arctostaphylos uva-ursi,* the young leaf showed practically no fat globules, while the old leaf was densely filled with such bodies.

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BOOK REVIEWS

A TAXONOMIC BOOK FOR ALL BOTANISTS

The teacher of botany who is not a trained taxonomist, yet who periodically has to conduct a class in local flora along with his many other duties, and that includes most of us, is almost sure to welcome Johnson's "Taxonomy of the Flowering Plants" which has recently appeared.[1] This large and difficult task has for many years been awaiting one with sufficient courage. If there are certain "deplorable" mistakes and oversights, as certain earlier reviewers have avidly pointed out at some length, we who work in the colleges and smaller departments, rather than the larger herbaria, must nevertheless accept the book for its immense practical value to the ordinary botanist and beginning taxonomist.

Fresh in style and method, adequate in technical descriptions and profuse in illustrations (there must be more than three thousand separate and original drawings in the 478 figures), Dr. Johnson's book is of constant reference value. Although neither a flora nor manual in the ordinary sense, good keys to the families of the various orders are included with the subfamilies distinguished by descriptions. Numerous genera and species of special interest or importance are described, frequently with notes of geographic or ecologic interest, and everywhere, I must reiterate, are the excellent critical drawings.

Part I devotes 145 pages to the following chapters: The Science of Taxonomy, Nomenclature, etc., The Flower, Calyx and Corolla, Andrœcium and Gynœcium, The Receptacle, The Fruit, The Inflorescence, and Vegetative Characters. This material is presented with a view to its utilization in the identification of plants; it does not profess to be morphology for its own sake and consequently avoids many controversial matters.

Part II devotes 550 pages to Systematics, including the following chapters: The Approach to Classification, Practical Suggestions, The Angiosperms, Dicotyledones, The Dialypetalæ, Metachlamydeæ (Sympetalæ), Tetracyclicæ, The Epigynous Tetracyclicæ, and Monocotyledones. Following is a glossary of about 1300 terms and a bibliography of about 1000 titles arranged alphabetically by authors within the following classifications: Manuals, Floras and Special Treatises, Manuals

[1]Johnson, Arthur Monrad. Taxonomy of the Flowering Plants. pp. xxi, 864. 478 figures. The Century Company: New York. 1931. $7.50.

and Handbooks of Trees and Shrubs, Grasses and Cereals, References of a Popular Nature, General Morphology, Phylogeny, Evolution and Taxonomy, Teratological Phenomena, Ecology, Phytogeography and Natural History, Forestry and Forests, Geological and Paleontological References. Also there is an adequate topical index and an index to the illustrations.

In the main, phylogeny, *per se*, is largely ignored. Some liberties may have been taken with certain systems (Dr. Johnson follows Engler and Gilg in the last edition of the *Syllabus*). Certain inconsistencies could be pointed out, but the reviewer, for one, is sure of the author's wiseness in minimizing the consideration of phylogenetic problems. The book is not intended to be a critical manual of phylogeny, to judge the merits of various systems proposed in the past nor to offer a new phylogenetic system. Altogether it is a most excellent and unique book which has long needed to be written, and by Dr. Johnson. A revision after a few years, which will correct the relatively few mistakes in keys, citations and text, should result in this book remaining "standard" far beyond the author's own time.—S. A. C.

OUR MOST BEAUTIFUL SHRUBS

Mr. Hume, who has written several books on gardening, especially for the Lower South, is himself an experienced gardener and not the ordinary journalistic spellbinder. One has confidence in his suggestions about growing "Azaleas and Camellias," the title of his latest book.[2] This little book is interesting reading, whether one lives where these plants can be grown out-of-doors or not, and Mr. Hume's enthusiasm for these profusely blooming and exquisite shrubs is contagious. For readers of a more technical botanical leaning, the chapter of Azalea Species and Varieties is valuable in gathering together information on the origin and relationships of the various native and imported Azalea groups: the Indian Azaleas, the Kurume Azaleas, Native American Azaleas, the Ghent Hybrids, etc. All those in private use and the trade are cataloged and briefly described. One thing, very much to be desired, is missing—a workable key to the plants dealt with. Other chapters consider their adaptability, propagation, site, soils, planting, use in the

[2]Hume, H. Harold. Azaleas and Camellias. pp. 90. 1 color plate, 6 halftone plates. The Macmillan Company: New York. 1931. $1.50.

garden, cultivation and care, feeding, potting and pathology. Camellias are equally dealt with, despite the limited space of the book.

Remarks about the affinities of our Southeastern flora with Japan and China, the widely disjunct nature of the distribution of related species, the Oriental and American centers of origin and extent of range, etc., give added interest to the plants one grows. You cannot go wrong for a dollar and a half.—S. A. C.